Energy Aware Handover in LBS Interference for 5G Dense Heterogeneous Network

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Abstract—**The key performance metrics for the Next generation wireless communication system is the Energy efficiency. We use dense Heterogenous Networks(HetNets) which comprises of Macro cell and Small cell where small cells include femto cell, pico cell, and micro cells. The femto cells are deployed in the macrocell area to improve the indoor coverage and provide better user experience. The mass deployment of femtocell faces a number of challenges among which interference management is very important. In this paper we consider the energy aware handovers between macro and femto base stations where the user equipment changes its services from one base station to another since the target one will offer better quality of performance. Handover decision can either be mobile initiated or network initiated and this decision is truly based on the received signal strength (RSS). The experiment is carried out using Network Simulator NS-3 and the results show that the proposed solution exhibits better performance in terms of quality of service metrics.**

I. Introduction

Communication is the essential part of our daily life. Technology has improved a lot and hence everyone looks for convenient and efficient way of communication. Considering this it is necessary to develop a system which is easy to deploy, easy to run and easy to access it. A location-based service(LBS) is a software-level service that uses location data to control features. LBS can be used in a variety of contexts, such as health, indoor object search, entertainment ,work and so on. LBS comprise the following components: a) Mobile positioning system – which helps in positioning of the mobile system b) Wireless Network - which delivers the service to the users. Their function is to connect positioning systems with the wireless network and the LBS application. c) LBS application – this application consists of spatial database and application server. d) LBS middleware - which facilitates the development and deployment of LBS applications in heterogeneous network environment. e) Application server – which is the processing center for a LBS platform that handles user interface function and communicates with the spatial database. Heterogeneous networks (HetNet) is a term which consists of the combination of various cell types and different access technologies which is mainly used for mobile communication. HetNets are used to provide end user coverage and seamless handover. A typical HetNet uses the combination of modern radio access technologies such as LTE, and it is a mixture of small cell and macro cells and in some cases WiFi access points. Figure 1 shows the architecture of LBS.

Wireless network is the major medium of communication between the people in today's tremendously growing world of Telecommunication. The demand of this type of communication is increasing day by day, therefore to handle this demand more wireless networks have to establish to obtain the high data rate requirement. By considering various technology and topology based cell layer of the coverage area the operators can provide a more consistent customer experience compared with the homogenous network. Also, a seamless changeover between the different layers and radio interfaces takes place without requiring the user to do anything. Small Cells create flexible and cost effective solutions for current and future coverage and capacity requirements.Macro cells are used to provide coverage. Pico cells and micro cells are used to enhance capacity in busy areas, such as train stations, shopping malls and city centers. Femto cells and Wi-Fi are used at the office and at home. Deployment of these small cell are a key feature of the HetNet approach as they allow considerable flexibility as to where they are positioned. Wi-fi can play a significant role in HetNets, both in terms of data offload and in terms of roaming, especially between an outdoor environment and an in-house environment. Network densification is measured as a key tool in the development of cellular networks, and the ultra-dense heterogeneous network (UDHN) is a promising technique to meet the requirements of explosive data traffic in 5G networks. In the UDHN, base station is brought closer and closer to users through densely deploying small cells, which would result in extremely high spectral efficiency and energy efficiency. To meet the increase in the traffic and to accommodate the massive devices the ultra-dense heterogeneous networks (UDHN) have been identified .The UDHN refers to the idea of populating the cellular networks with a very high network densification, including both the mobile device densification and base station (BS) densification, where the density of BS may increase that of mobile device. Due to this, the UDHN would potentially permit for orders of magnitude improvement in both spectral efficiency (SE) and energy efficiency (EE). The more traffic generated, the more BSs will be needed to assist the devices. The evolution of the cellular networks, i.e., from 1G to 5G, can be viewed as the

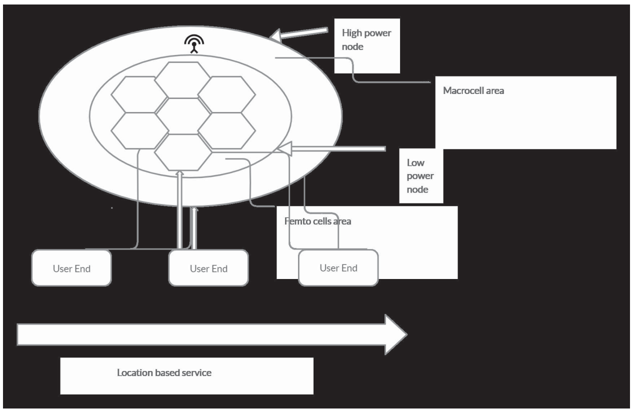

Fig. 1. Architecture of LBS

process of network densification to some extent. In 1G network, the cell radius is around 10 miles, and cell splitting may occur, where the radio coverage of one cell is partitioned into two or more new smaller cells to mitigate path-loss and to support more devices. In 2G networks, the typical radius of macrocell varies from a couple of hundred meters to several kilometres. Besides cell splitting, small cells, which are low-powered radio access nodes that have a range of tens of meters to 1 or 2 kilometers, are introduced in 2G networks to offload traffic from macrocells. In 3G and 4G networks, small cells are further popular and viewed as a vital element for boosting network throughput and balancing traffic load. Deploying more and more small cells to serve a certain geographical area leads to smaller and smaller cell coverage areas, and thereby achieving cell splitting gains. With small cells being deployed, homogeneous cellular networks become heterogeneous because of difference in transmit power and coverage area of BSs. In 5G networks, the density of small cells will be further increased compared with that in 4G networks to guarantee seamless coverage and high data rate. As a result, the UDHN is emerging as one of the core characteristics of 5G cellular networks. However, the performance of the UDHN does not increase monotonously with BS density, and it is limited by the inter-cell interference and the front haul and backhaul network capacity. The full benefits of network densification can be realized only if it is complemented by advanced transceivers capable of interference cancellation and backhaul densification A handover is a process in telecommunications and mobile communications in which a connected cellular call or a data session is transferred from one cell site (base station) to another without disconnecting the session. In this case there is a handover between the femto and macrocell. The handover process in cellular networks enables a UE that is already connected to a serving cell to transfer its connection to a neighboring cell while maintaining quality of service at an acceptable level [9]. Network densification intensifies the already existing challenges of managing handovers for mobile UEs. Since SCBS coverage is much smaller than that of MBS, handovers for mobile UEs are much more frequent [3]. Due to the variety of coverage footprints of HetNets, a mobile UE cannot use the same set of handover parameters as those used in a homogenous network. Instead, a mobile UE must use cell-specific handover parameters [10]. Another factor aggravating the problem occurs when handover decisions are based solely on the received signal strength at the mobile UE (downlink). Since downlink transmission powers for macro and small cells are disproportionate, handovers might be unnecessary performed. Hence, it is required to simultaneously consider both downlink and uplink which could be challenging [3]. Furthermore, the mobility of UEs traveling at different speeds is a major factor that must be considered in the presence HetNets with large dense deployments of small cells. Triggering suboptimal handovers could occur for high mobile users. Thus, consideration of mobility and received signal strength of users should be included for inter-tier handover decisions.

A. Location based services

Location Based Services also known as wireless location services, is an advanced technology which gives information or creating information which is accessible based on the geographi-cal position of the user. By means of this we can know the users position at any given time. This kind of service provides the following dimensions. People Tracking and Finding, Directions for driving, Directory service information.

LBS offers users with the matters being customized by the user's existing location, such as the nearby restau-rants/hotels/clinics, which are taken from a database stored in the LBS server. LBS also plays a major role in the public safety, disaster management also in the emergency response. The rest of the paper is organized as follows: Section II define the problem statement and Section III discuss related previous works. Section IV presents the proposed mathematical model for the proposed system and Section V presents the algorithms. The results are discussed in Section VI, and conclusion and scope for future work is presented in section VII.

II. Problem statement

The goal is about presenting the location based services to the customers using handover between macrocell and femtocell . Interference is one of the major issue during the handover between femtocell and the macrocells. Handover are used to reduce the problem of interference only if resources are made available otherwise the handover will decrease the performance of the network .The distance between the macro base station (MBS) and femto Access Point is short it is very hard to lower the handover probability when the user moves from Macro Base station to femto access point.

III. Related works

The first generation to help in the growth of the location information is the fifth generation of technology (5G) which is sufficiently precise to be furnished in the wireless network design and optimization. Racco et.al [2], describes that the information about the location that can aid in giving various of the key challenges in 5G, which helps in balancing to the existing and planned technological growths. These challenges involves an increase in traffic and number of devices, robustness for mission-critical services, and a reduction in total energy consumption and latency.

Jianping et.al ([4],2017), describes the exponentially improved demands of mobile data traffic, e.g., a 1000-fold improvement in the traffic demand from 4G to 5G, network densification is considered as a key mechanism in the evolution of cellular networks, and ultra-dense heterogeneous network (UDHN) is a promising technique to meet the requirements of explosive data traffic in 5G networks. The authors explains that in the UDHN, the base station is carried closer and closer to users by means of densely deploying small cells, which would result in enormously high spectral efficiency and energy efficiency. By deploying the small cells homogeneous cellular networks become heterogeneous because of variations in transmit power and coverage area of BSs.

In this paper Huaiyu Liu et.al([5],2009) describes the need for the use of a cost function which is used to perform an optimal network selection using information provided by these standards, such as network coverage map or network properties. The cost function facilitates the flexibility to balance various factors in the decision making, and the authors are focused on improving both seamlessness and energy efficiency of the device and handovers. Authors evaluated this approach which is dependent on the usage scenarios over WiFi, WiMax, and 3G networks using captured signal strength traces and the resultant schemes will select the optimal networks and handovers were generated at appropriate times which is to improve the network connectivity as compared to traditional prompting schemes.

Authors ZHENNI PAN et.al ([6],2019)proposes the P-persistent energy aware handover (HO) decision strategies with mobility robustness for intra-handover cases. While a femto user equipment (FUE) wanders into another femto access point (FAP) and for cross-tier handover cases while a macro user equipment (MUE)/FUE wanders into/out of the FAP in a dynamic cell sizing involving macro-femto two-tier networks. This prediction of HO trigger is closely determined by a P-persistent decision mechanism which formulates the precise HO behaviors when an MUE/FUE roams into (HO-in) and out of (HO-out) a femtocell in terms of the correlated coverage variance and UE trajectory features, whereas the target selection follows a utility function in consideration of the UE traveling time and the achievable throughput

Authors Feras Zenalden, Suhaidi Hassan and Adib Habbal([7],2015) have proposed a model for vertical handover for heterogeneous networks and provides solution to different types of vertical handovers between the wireless media such 5G to WiFi,4G to 5G,3G to 5G etc. The authors provide a approach for better customer experience such as high quality of service (QOS) and high quality of experience(QOE). A decision making algorithm for vertical handover is proposed based on received signal strength (RSS) and signal to interference noise ratio (SINR). Two different types of handover are proposed handovers based on network type and handovers based on network frequency.

Authors Mike Koivisto et.al.([8],2017) have proposed a model to obtain Continuous high accuracy (sub meter range) positioning of cars in Ultra-dense 5G Networks. In case of DoA and ToA Estimation and Tracking, the periodically transmitted UL pilot signals are utilized for the estimation of DoAs and ToAs at each LoS-Access Nodes before communicating and utilizing these estimates for positioning purposes in a central entity of a network. Here they've used EKF-based solution for DoA and ToA estimation and tracking due to its appealing properties such as high-accuracy estimation and relatively low computational complexity and tracking performance. They've used two models where the first model assumes that a given UE is moving with constant velocity(CV) and in second model considers constant acceleration(CA)

Energy saving is necessary in the presence of femtocells, due to the vastly overlapping cell coverage and the dense network layout. Dionysis Xenakis et.al([9],2013) describes that the Interference management is critical in the LTE-A femtocell network as well, to mitigate the negative impact of cross-tier interference on the Signal to Interference plus Noise Ratio (SINR) performance.The proposed algorithm achieves backwards compatibility with the LTEAdvanced system, as it is installed by using the private mechanism for non-standard use. Authors have validated the performance of the proposed algorithm and have compared it against that of other state-of-the-art algorithms. This validation is based on the evaluation methodology of the Small Cell forum.

G¨urkan Cokun et.al([10],2014) describes the network conditions depending on theQoS requirements of users, the authors also explains the usage of the right technology at the right time can provide more effective networking with higher data rate, lower cost, longer battery duration, and higher coverage area. To enable this networking effectiveness, authors have used seamless handover mechanism to minimize service disruption. A new algorithm is proposed to provide energy efficient handovers among UMTS, WiMAX, and WLAN networks. The proposed algorithm is implemented within the IEEE 802.21 framework and its performance analysis is performed using the ns-2.29 simulator

Authors Lizeth Gomez et.al ([11],2016), considers the energy efficient handovers between macro and femto base stations with transmit power control. The handovers are made considering the constraints in the available radio resources at the femto base stations which plays an important role in regulating the energy efficiency performance gain of such systems. Authors presents the handover algorithm and simulates for a single macro-cell scenario with multiple femto-cells and under shadow fading conditions and finally by analyzing the energy efficiency performance of the algorithm with radio resource constraints in the femtocells. The results specify that there is more scope to save energy when more radio resources are allocated in the femtocells, especially when the users are geographically clustered.

Authors Mike Koivisto et al. ([12], 2017) have proposed a survey to focus on user equipment (UE) positioning, and additionally show how also successful network synchronization can be done in 5G networks in a highly sophisticated, but low-complex network centric solution

Authors Mostafa Zaman Chowdhury et al. ([?], 2009) have proposed the concentrator based and without concentrator based femtocell network architecture. Then they present the signal flow with appropriate parameters for the handover between 3GPP UMTS based macrocell and femtocell networks.

Author Aki Hakkarainen et.al.([?],2015) have proposed a model for Device Localization in 5G Ultra-Dense Networks in a highly efficient manner. A localization system is designed that meets the location based service demands. The accuracy of this model is in the sub-meter range. The power consumption is improved for the user nodes(UN) since the size of the cells are reduced in the 5G network

IV. Mathematical model

This section discusses about the mathematical model of the existing model and to help propose a new model to carry out investigation.

A. Existing model

In the existing model approach, received signal level of neighbour networks is periodically measured, and the network (in terms of higher signal level) is selected as the current access network.

The flow control during the best network selection process is as shown

1) Neighbour Femtocells are detected
2) The signal levels of network provider and Macrocell networks are measured and stored. This is done without disconnecting from current access network.
3) Stored values of signal levels are compared to decide which network is best, and connection to best network is made.
4) The steps (1-3) are repeated at regular time intervals.

The Evaluator component was implemented as a stand-alone user-mode application called signal strength. To implement it, they used Qt Mobility APIs, particularly the QSystemNetwork-Info class; and the iwlist utility from the wireless-tools package. While iwlist utility returned signal strength in decibels above milli watt (dBms) Qt Mobility API used percentage values. These were converted to dBm using techniques from “Converting Signal Strength Percentage to dBm Values”

The Evaluator component of the existing solution uses the network fitness for complex network evaluation scenarios, which is defined as a weighted sum

$$f = \sum w_{1i} RFIP_i^2 + \sum w_{2j} RSIP_j - P, [\textbf{?}] \qquad (1)$$

where RFIPs [1,5] are ratings of the most important network parameters (Signal Level, Throughput, and so on), RSIPs [1,5] are ratings of the less important parameters (e.g. Jitter and Latency), wkl are parameter weights, and P is a static penalty typically applied to non-home networks (which are potentially costly). The Evaluator can then choose network with the biggest value of (1) as the ”best”.

B. Proposed model

The general flow of control during the network switching process.

1) The location of the sender and receiver is found by network provider.
2) The distance between the sender and the receiver is calculated
3) Handover to Macrocell or Femtocell is based on the threshold and distance

1) Position: The position provides the latitude and longitude of a node with the help of Global Positioning System (GPS), The node can be a User Equipment (UE) node, a Femtocell or a Macrocell Access Point (AP) node. Let $P_{i,t}$, lat and long represent position of node 'i' at time 't', latitude of the node given by the GPS at time 't' and longitude of the node given by the GPS at time 't' respectively. The position of each node 'i' in a rectangular area of simulation at the time 't' is calculated using,

$$P_{i,t} = (lat, long) \tag{2}$$

2) Velocity: The velocity vector provides the speed and direction of a node. Let P1 and P2 be the two positions of a single node 'i' at time t_1 and t_2 The displacement of node 'i' between two positions P1 and P2 at instance t is given by Euclidean equation,

$$dist(i, \theta, t) = \sqrt{(lat1 - lat2)^2 + (long1 - long2)^2} \tag{3}$$

where lat1 = latCosθ1, lat2 = lat Cosθ2, long1 = long Cosθ1, long2 = long Cosθ1 and θ i= angle of displacement of node i. Velocity v(i,j,t,θ)for displacement of node n from position i to position j from time t1 to t2 is given by,[3]

$$v_{i,j,t,\square} = dist_{n,\square,t}/(t_2 - t_1) \tag{4}$$

3) Mobility: In ns-3, special MobilityModel objects track the evolution of position with respect to a (cartesian) coordinate system. The mobility model is typically aggregated to an ns3::Node object and queried using GetObject¡MobilityModel¿ (). The base class ns3::MobilityModel is subclassed for different motion behaviors.

The initial position of objects is typically set with a PositionAllocator. These types of objects will lay out the position on a notional canvas. Once the simulation starts, the position allocator may no longer be used, or it may be used to pick future mobility waypoints for such mobility models.

Most users interact with the mobility system using mobility helper classes. The MobilityHelper combines a mobility model and position allocator, and can be used with a node container to install mobility capability on a set of nodes.

- Constant Position Mobility Model
  Mobility model for which the current position does not change once it has been set and until it is set again explicitly to a new value. [13]. The nodes such as Tower nodes and Wi-Fi Access Point (AP) nodes use this mobility model in the simulation of the proposed model. The position of the nodes in this mobility model remains in a constant position unless otherwise changed explicitly. Hence the ability to change node position can be defined using,

$$\text{ChangeLocation} = \begin{cases} 1, & \text{if location=new value} \\ 0, & \text{otherwise} \end{cases} \tag{5}$$

- Constant Velocity Mobility Mode
  Mobility model for which the current speed does not change once it has been set and until it is set again explicitly to a new value. [14]. The User Entity (UE) node use this mobility model in the simulation of the proposed model. The position of the nodes in this mobility model remains in a constant position unless otherwise changed explicitly. The velocity of the nodes in this mobility model remains constant unless otherwise changed explicitly. Hence the ability to change node velocity can be defined using,

$$\text{ChangeV elocity} = \begin{cases} 1, & \text{if velocity= new value} \\ 0, & \text{otherwise} \end{cases} \tag{6}$$

4) Threshold Distance: The Threshold distance is the maximum distance over which the vertical handover occurs. Consider an ideal condition with no obstructions, reflections from buildings and no reflections from the ground between the sender and the receiver. The threshold distance can be calculated using Friss transmission equation [1].

$$P_r = P_t + G_t + G_r + 20log_{10}(\lambda/4\pi d) \tag{7}$$

$$d = (\lambda/4\pi).10^{(P_t+G_t+G_r-P_r)} \tag{8}$$

Where, Pr = Power of receiving antenna, Pt = Power of transmitting antenna, Gr = Gain of receiving antenna, Gt = Gain of transmitting antenna and λ= wavelength of radio wave. d =Friss transmission distance. Threshold distance T_d is given by,

$$T_d = d \tag{9}$$

5) Handover: Consider two nodes with position 'P1' and 'P2' with lat1, lat2 and long1, long2 as their respective latitude and longitude let 'dist' be the Euclidean distance between the two nodes. 'dist' is calculated using equation 3

there 4 types of handover

- Horizontal Handover from Macrocell to Macrocell
  Consider 'n' Macrocell access point(AP) present in the simulation area Let a user node moving with velocity 'v' be connected to an 'AP_i' and 'R_i' be its range,where 'i' denotes 'i'th Macrocell access point. When the user node moves away from the connected AP_i the Euclidean distance between the user node and the AP_i increases, as distance becomes more than the range R_i the user node disconnects from the AP_i.Let $D_{AP\,j}$ be the node distance from UN_i to AP_j . if the user node is present within the range any other AP the the user node gets connected to that AP then the Macrocell - Macrocell
  Handover Criteria HH_{M-M} is calculated using

$$HH_{M-M} = \begin{cases} 1, & \text{if } D_{AP\,j} < R_j \, 0, \\ & \text{otherwise} \end{cases} \tag{10}$$

- Horizontal handover from Femtocell to Femtocell Consider 'n' 5G network tower(NT) present in the simulation area Let a user node moving with velocity

TABLE I. SYMBOLS USED IN ALGORITHM

Symbols	Meanings
$User1_x$	latitude of User1
$User2_x$	latitude of User2
$User1_y$	longitude of User1
$User2_y$	longitude of User2
Macrocell [x][y]	cordinates of Macrocell
Femtocell [x][y]	cordinates of Femtocell
User [a][b]	cordinates of User
Connected Macrocell1	User1 connected to Macrocell1
Connected Macrocel2	User2 connected to Macrocel2
nMacrocell	Array of Macrocells
nUser	Array of users

'v' be connected to an 'NT_i' and 'R_i' be its range, where 'i' denotes 'i'th 5G network tower. When the user node moves away from the connected AP_i the Euclidean distance between the user node and the NT_i increases, as distance becomes more than the range R_i the user node disconnects from the NT_i. if the user node is present within the range any other NT the the user node gets connected to that NT.Let D_{APj} be the node distance from UN_i to AP_j.Then the Femtocell-Femtocell Handover Criteria HH_{G-G} is calculated using

$$HH_{F-F} = \begin{cases} 1, & \mathbf{i}f \quad D_{APj} < NT_j \\ 0, & \textbf{otherwise} \end{cases} \qquad (11)$$

- Vertical handover from Femtocell to Macrocell Consider 'n' 5g network tower(NT) and 'm' Macrocell access point(AP) present in the simulation area. Two user nodes that are connected to the Femtocell NT, the NT that are connected to the nodes may be same or different. If the Euclidean distance between two nodes are less than that of the twice the threshold distance (2.8) and there exists a Macrocell AP such that both the user node can be connected to that AP, then there is a vertical handover from Femtocell to Macrocell and both the user nodes get connected to the same AP.Let D_{ij} be the node distance from UN_i to UN_j.Then the Femtocell-Macrocell Handover Criteria VH_{G-W} is calculated using

$$VH_{F-M} = \begin{cases} 1, & \mathbf{i}f \quad D_{ij} < 2T_d \\ & \&UE_1, UE_2 \epsilon AP_i \\ 0, & \textbf{otherwise} \end{cases} \qquad (12)$$

- Vertical handover from Macrocell to Femtocell Consider 'n' Macrocell (NT) and 'm'Femtocell access point(AP) present in the simulation area. Two user nodes that are connected to a single AP If the Euclidean distance any one of the node becomes greater than the threshold distance(2.8) then then there is a vertical handover from Macrocell to Femtocell and both the user nodes get connected to their respective NT Let D_{APj} be the node distance from UN_i to AP_j.Then the Macrocell-Femtocell Handover Criteria VH_{W-G} is calculated using

$$VH_{W-G} = \begin{cases} 1, & \mathbf{i}f \quad D_{APj} > T_d \\ 0, & \textbf{otherwise} \end{cases} \qquad (13)$$

This chapter includes about the implementation of the project along with the different algorithms that are used in our project. There are 4 different algorithms that are used here. The code snippets that are executed are also included in the chapter.

V. ALGORITHM

Algorithm 1 shows about the Vertical handover that takes place between Macrocell and Femtocell Network. Initially we check if the connected Macrocell1 and connected Macrocell 2 are equal and we find distance D1 and D2 using Euclidian formula3. If both D1 and D2 are more than the threshold distance then initiate the handover from Macrocell to Femtocell.

Algorithm 1: Vertical Handover from Macrocell to Femtocell

```
Input : User1x,User1y,User2x,User2y,connected
   Macrocell1,connected Macrocell2,threshold distance.
Output : Return true if handover occurs else return
   false.
Begin
 If (connected Macrocell1 == connected Macrocell2)
   Then
     D1⇒sqrt(User1x-Macrocellx)^2 -
   (User1Y-MacrocellY)^2
     D2⇒sqrt(User2x-Macrocellx)^2 -
   (User2Y-MacrocellY)^2
       If distance1 && distance2 < Threshhold
   distance
         then,
           Return False
       end if
           else
           Return true
           //initiate handover from Macrocell to
   Femtocell
 end if
```

Algorithm 2: Vertical Handover from Femtocell to Macrocell

```
Input :
   User1x,Femtocell1y,Femtocell2x,Femtocell2y,connected
   Macrocell1, connected Macrocell2, threshold
   distance.
Output : Return true if handover occurs else return
   false.
Begin
 If (connected Macrocell1 == connected Macrocell2)
   Then
     D1⇒sqrt(Femtocell1x-Macrocellx)^2 -
   (User1Y-MacrocellY)^2
     D2⇒sqrt(Femtocellx-Macrocellx)^2 -
   (User2Y-MacrocellY)^2
       If distance1 && distance2 < Threshhold
   distance
         then,
           Return False
       end if
           else
           Return true
           //initiate handover from Femtocell to
   Macrocell
 end if
```

Algorithm shows about the Vertical handover that takes place between Femtocell and Macrocell Network. Initially we check if the connected Macrocell1 and connected Macrocell 2 are equal and we find distance D1 and D2 using Euclidean formula3.

If both D1 and D2 are more then the threshold distance then initiate the handover from Femtocell to Macrocell.

Algorithm 3: Connect to the Macrocell

```
Input : Macrocell [x][y], user [a][b],Macrocell Range,
  nMacrocell, nUser
Output : Every node is connected to the Macrocell
  within the Macrocell range.
Begin
    For every user_i in nUser
        For every Macrocell_i in nMacrocell
            D⇒ sqrt(x - a)^2 + (y - b)^2
            If d < min && d < Macrocell range
  then,
                Min = d
                Node= Macrocell_i
            End If
        End For
    End For
    // Macrocell for user_i is Macrocell with min
  (d)
    Return: Connected to Macrocell[i]=node
End
```

Algorithm 3 shows about the connection of the user nodes to the Macrocell network. Initially we check for every particular user in n-users and every Macrocell in n-Macrocell network, we find the distance using Euclidian distance formula3. If the distance is less than the minimum and less than the Macrocell range then we fix that distance as minimum and that Macrocell to the user node and we return connected to which particular Macrocell access point.

Algorithm 4: Connect to the Acess Point

```
Input : Tower [x][y], user [a][b],Tower Range,
  nTower, nUser
Output : Every node is connected to the Tower within
  the Tower range.
Begin
    For every user_i in nUser
        For every Tower_i in nTower
            D⇒ sqrt(x - a)^2 + (y - b)^2
            If d < min && d < Tower range
  then,
                Min = d
                Node= Tower_i
            End If
        End For
    End For
    // Tower for user_i is Tower with min (d)
    Return: Connected to Tower[i]=node
End
```

Algorithm shows about the connection of the user nodes to the 5G Tower network. Initially we check for every particular user in n-users and every Tower in n-Tower network, we find the distance using Euclidian distance formula3. If the distance is less then the minimum and less then the Tower range then we fix that distance as minimum and that Tower to the user node and we return connected to which particular Tower.

VI. Results and Analysis

A. Graphs

- **Case I**

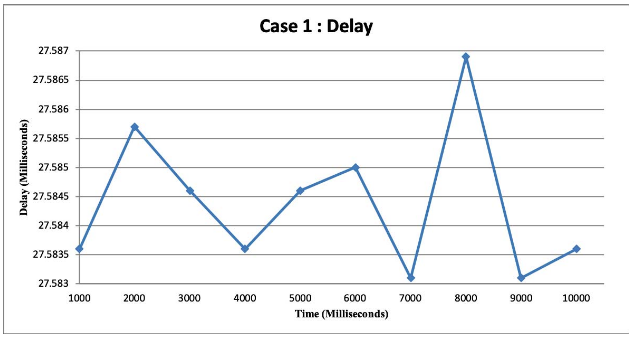

Fig. 2. Case I:Delay

Delay: In Fig. 2 the values are obtained when both the users are stationary and the delay time is very minimal in this case since both users are not moving.

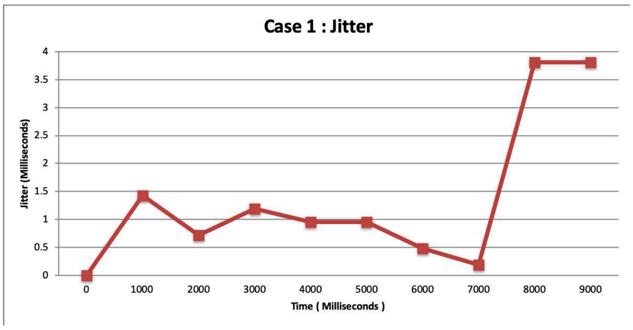

Fig. 3. Case I:Jitter

Jitter: In Fig. 3 the values are obtained when both the user is stationary and the jitter is very minimal in this case since both users are not moving. There is sudden increase in the jitter time because the handover happens due to weak signal or access point is not properly working.

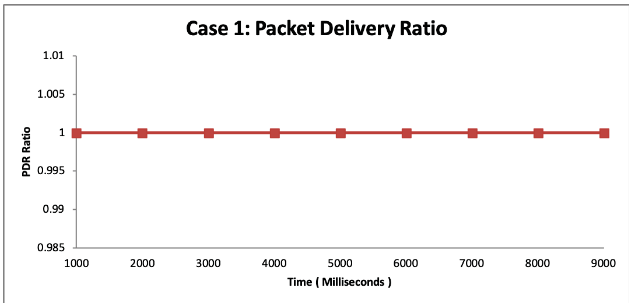

Fig. 4. Case I:Packet Delivery Ratio

Packet Delivery Ratio:In Fig. 4 the values are obtained when both the users are stationary and the packet delivery ratio is very high in in all cases of the simulation. That is because in this simulation, there are only two user

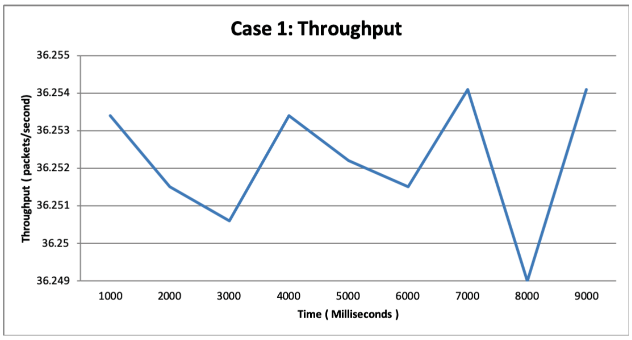

Fig. 5. Case I:Throughput

nodes and the traffic is very less. Thats why the packet delivery ratio is very high.

Throughput:In Fig. 5 the values are obtained when both the users are stationary and the throughput is very high in this case since both users are not moving.

- Case II

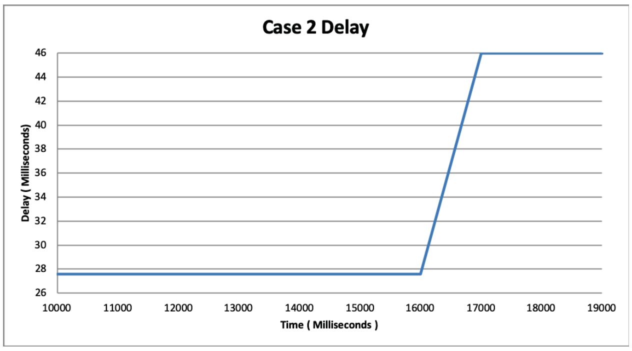

Fig. 6. Case II:Delay

Delay:Here in this case one user node is moving and an-other node is stationary. As shown in Figure 6 the delay time is very minimal until the handover happens. When handover happens the delay time suddenly increases. In figure 6.5 the handover happens at 15000 milliseconds and we can see a spike in the graph.

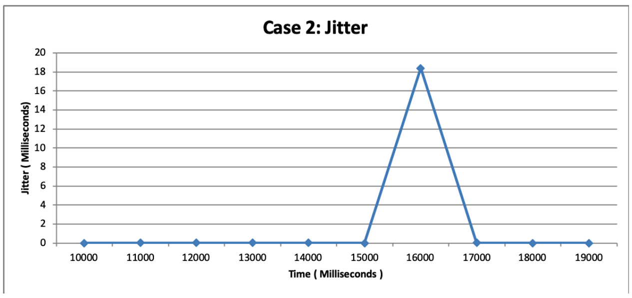

Fig. 7. Case II:Jitter

Jitter:Here in this case one user node is moving and another node is stationary.The jitter time is very minimal until the handover happens. Once the handover is over the jitter time very minimal. In Fig. 7 the handover happens at 15000 milliseconds and we can see a spike in the graph.

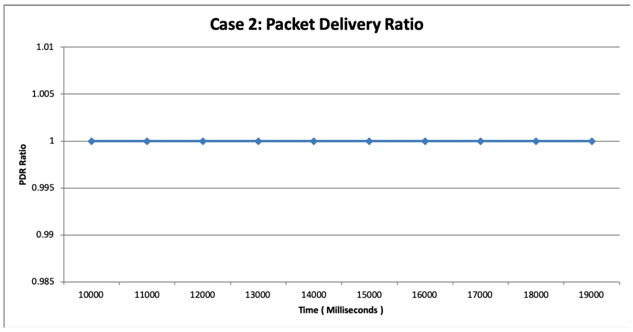

Fig. 8. Case II:Packet Delivery Ratio

Packet Delivery Ratio:In Fig. 8 one user node is moving and another node is stationary and the packet delivery ratio is very high in in all cases of the simulation. That is because in this simulation, there are only two user nodes and the traffic is very less. Thats why the packet delivery ratio is very high.

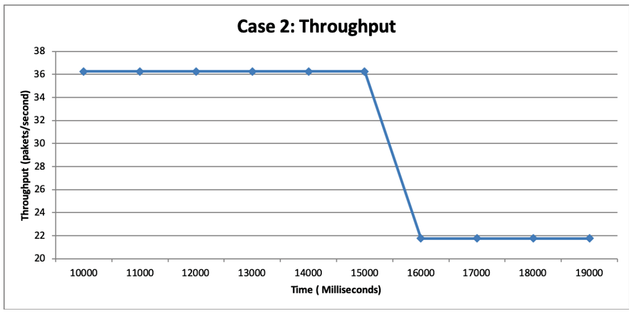

Fig. 9. Case II:Throughput

Throughput: In this case the handover happens from Macrocell to Femtocell. In Fig. 9 throughput rate is high and after the handover from Macrocell to Femtocell throughput rate decreases because the capacity is 5G network is lower when compared to Macrocell.

- Case III

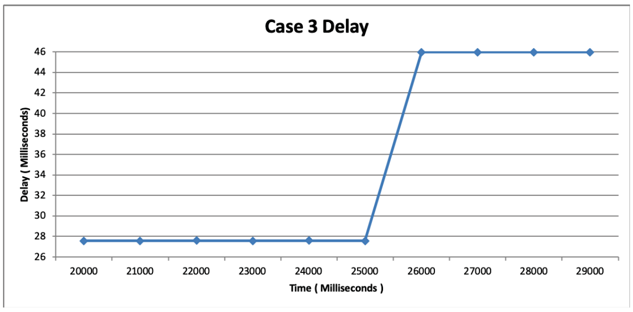

Fig. 10. Case III:Delay

Delay:Here in this case one user node is moving and an-other node is stationary. As shown in Fig. 10 the delay time is very minimal until the handover happens. When handover happens the delay time suddenly increases. In Figure 6.9 the handover happens at 15000 milliseconds and we can see a spike in the graph.

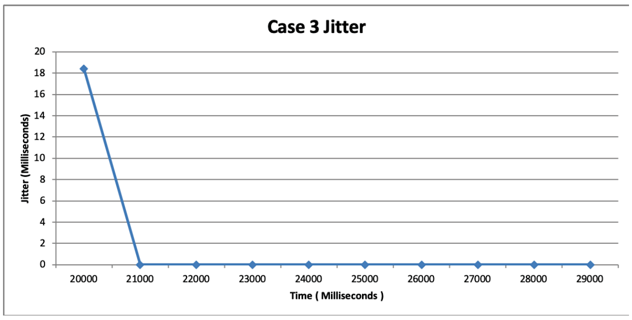

Fig. 11. Case III:Jitter

Jitter:Here in this case one user node is moving and an-other node is stationary. As shown in Fig. 11 the jitter time is very minimal until the handover happens. Once the handover is over the jitter time very minimal. In Figure 6.10 the handover happens at 15000 milliseconds and we can see a spike in the graph.

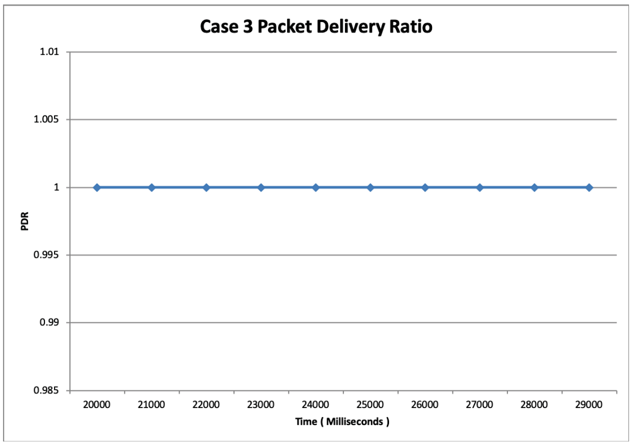

Fig. 12. Case III:Packet Delivery Ratio

Packet Delivery Ratio: In Fig. 12 one user node is moving and another node is stationary and the packet delivery ratio is very high in in all cases of the simulation. That is because in this simulation, there are only two user nodes and the traffic is very less. Thats why the packet delivery ratio is very high

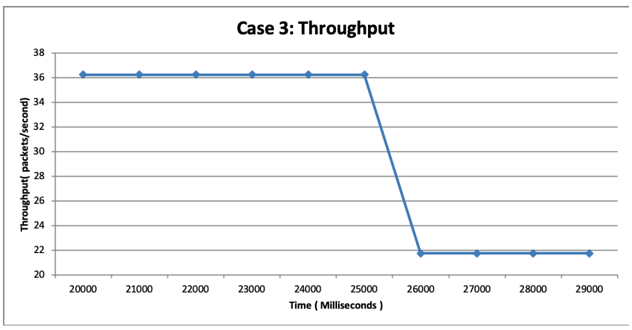

Fig. 13. Case III:Throughput

Throughput: Here in this case one user node is moving and another node is stationary and the handover happens from Macrocell to Femtocell. In Fig. 13 throughput rate is high and after the handover from Macrocell to Femtocell throughput rate decreases because the capacity is Femtocell network is lower when compared to Macrocell.

- Case IV

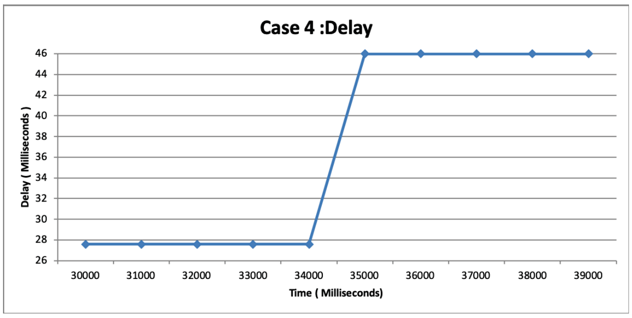

Fig. 14. Case IV:Delay

Delay:Here in this case both the user node is moving. As shown in Fig. 14 the delay time is very minimal until the handover happens. When handover happens the delay time suddenly increases. In Figure 6.13 the handover happens at 15000 milliseconds and we can see a spike in the graph.

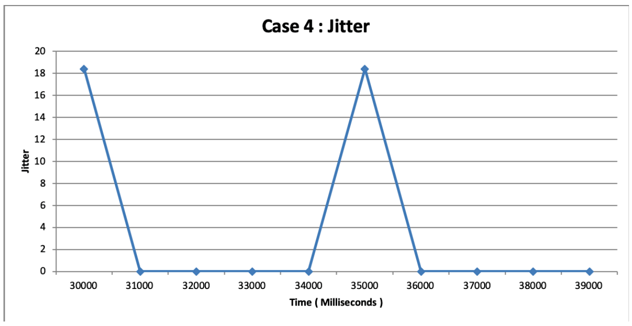

Fig. 15. Case IV:Jitter

Jitter:Here in this case both the user node are moving. As shown in Fig. 15 the jitter time is very minimal until the handover happens. Once the handover is over the jitter time very minimal. In figure the handover happens at 15000 milliseconds and we can see a spike in the graph.

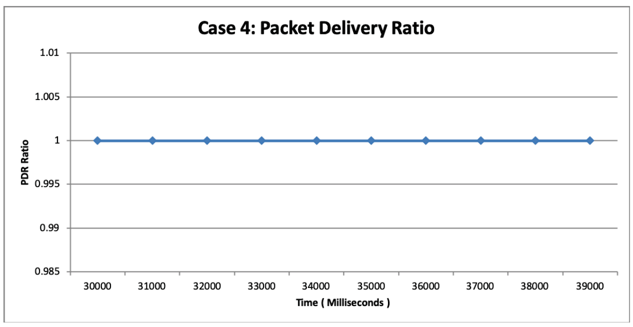

Fig. 16. Case IV:Packet Delivery Ratio

Packet Delivery Ratio: In Fig. 16 both user node are moving and the packet delivery ratio is very high in in all cases of the simulation. That is because in this simulation, there are only two user nodes and the traffic is very less. Thats why the packet delivery ratio is very high.

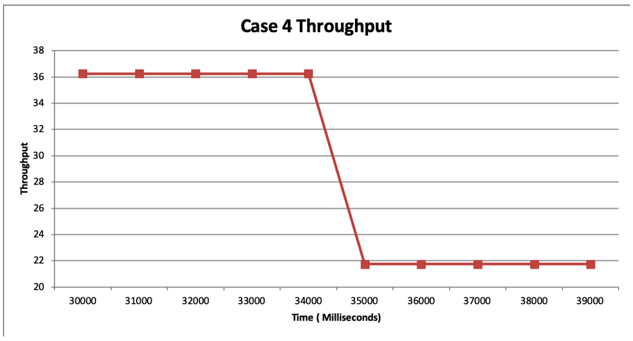

Fig. 17. Case IV:Throughput

Throughput: Here in this case both the user node is moving and the handover happens from Macrocell to Femtocell. In Fig. 17 throughput rate is high and after the handover from Macrocell to Femtocell throughput rate decreases because the capacity is Femtocell network is lower when compared to Macrocell.

VII. Conclusion and Future work

In this paper we presented the energy efficient handover algorithm with switching over calls between macrocell and femtocell base station. A detail study is made on the energy consumption due to the factor of interference and the results are analyzed considering the handover method. The results indicate that there is much scope to save energy and in the near future the work can be focused on the detail power consumption parameters, and build a more realistic power consumption model.

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